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"A supply Chain Management Framework for Indian Passenger Car Sector in the perspective of Economic Uncertainty"

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Abstract:

Supply chain management becomes vulnerable during economic slowdown. All concepts relating to push and pull strategy become reclusions. The management of supply chain during **"Recovery"** period requires new innovative approaches to recover from economic slowdown and market uncertainties. A holistic methodology encompassing systems, contingency and driver approaches needs to be developed. Many researchers have suggested models that are deterministic in nature neglecting the uncertainties, or proposed stochastic models but less study is known to exists that enables simulating the decision-effect during market recovery. This paper proposes a System Dynamics Model for capturing the post-recession dynamics and its impact on supply chain performance.

Keywords: *Causal Model, Market-Recovery, Supply chain management, Simulation, System Dynamics.*

Paper Type: Research Paper

Introduction:

From economist's point of view the term **Recovery** means "a period of increasing business activity signalling the end of a recession. Much like a recession, an economic recovery is not always easy to recognize until at least several months after it has begun". Economists use a variety of indicators, including GDP, inflation, financial markets and unemployment to analyze the state of the economy and determine whether a recovery is in progress.

During period of economic recovery organizations explore all available opportunities and build resources as well as capabilities for growth and sustainable development. Supply chain management becomes vulnerable during economic slow-down. All concepts relating to **Push and Pull Strategy** become reclusion. The management of supply chain during "**Recovery Period**" requires new innovative approaches to recover from economic slowdown and market uncertainties.

Research Background:

To survive with the worst economic downturn, it's critical that manufacturers look ahead and prepare for the eventual economic recovery. Historical data indicates that it's the period immediately following a recession that offers the most opportunity for businesses.

According to the recent Quarterly Economic Forecast issued by Manufacturers Alliance/MAPI, there are enough economic indicators to forecast an eventual, though modest, recovery following a long and deep recession. Manufacturers must ensure they have a solid foundation to effectively and profitably leverage the opportunities that a recovering economy will offer.

Although there is much speculation on the rate of the economic slow-down, some indications suggest that consumers' frugal spending behavior during the recession may last well into the recovery period and beyond. Given this situation, manufacturers should recalibrate their supply chains now to assist them in operating successfully in today's "new normal" environment, effectively navigate the recession-recovery cycle and lay the groundwork for future growth.

Methodology:

To construct this paper the following methodology has been adopted-

1. Literature review
   a. Identifying the causes of market downfall
   b. Analysis of strategies during recovery
2. Identifying the variables and their causality
3. Develop a system dynamic model for decision making during market recovery.

Literature Review:

World trade patterns are changing- At the start of the 1990s, global trade was dominated by the developed nations; by 2010, the advanced economies accounted for a little more than 60% of global merchandise exports.

Supply chains are transforming- In response to these changing patterns in global trade, companies are rapidly transforming their supply chains to go wherever necessary to support growth and reduce costs and risks. For many companies, supply chain activities — such as product engineering, sourcing, manufacturing and logistics — are now widely dispersed around the world. As activities are outsourced, the efforts are directed to centralized and streamlined supply chain management to gain efficiencies and maximize scarce resources; the corporate structures and functions are also being transformed (Pankaj M. Madhani, 2012).

Challenges to overcome- The challenges are as follows:

- Changing demand patterns that have led to more complex and global supply chains

- An evolving customer base, caused by new customers from emerging economies entering the market and traditional customers aggressively seeking ways to reduce costs
- Difficulty establishing strategic relationships with shippers as some parts of the offering become commoditized and the cost of switching providers is reduced
- "Green" mandates from shippers reflecting differing regulations around the world

Some Vital Recession-Recovery Strategies:

Outlined below are vital recession-recovery strategies for manufacturers to effectively mitigate supply chain risks, quickly respond to opportunities associated with the economic recovery, as well as operate a more efficient and competitive business.

- **Strengthen Cash Position-** Manufacturers that can free-up unnecessary inventory and keep it lean will have the flexibility to change business strategies or respond to any market surprises. One way to strengthen cash position is to continue rationalizing inventory levels against the changing product mix across the entire supply chain so that levels are optimally aligned with current consumer demand. Cash is also essential for companies to establish a healthy framework for growth, whether that consists of new product innovations, expansion into new markets or merger and acquisition activity.
- **Realign the Supply Chain to Achieve Financial Goals-** In addition to addressing real-time supply chain issues like replenishment and forecast planning; it's time for manufacturers to think strategically about their businesses over the long term. An effective way to achieve this is to take control of financial and operational strategies with a revised approach to sales and operations planning (S&OP). An integrated business planning approach goes beyond supply-demand balancing and integrates time-phased strategic revenue, cost and margin plans with a company's operational plans. This also enables executives to more accurately set financial expectations for all sales, marketing, promotion, inventory and capital expenditure plans.

Analysis:

Thusit can be summarized as:

- Market volatility leads to uncertainty in demand.
- The uncertainty in demand generates the fluctuating inventory level and therefore stock out and obsolescence.
- The result is ultimately the loss of goodwill and reduction in profit margins.

As a result, The Supply Chain Manager has to ensure that it avoids the above pitfalls.

Supply Chain-There are three distinct aspects regarding a supply chain of a firm**.** Firstly, supply chain is formed by many entities, each entity being a separate complex system. Secondly, the activities which take place in these entities should be taken into account, as these causes the flow of goods and customer service in the supply chain. Thirdly, supply chain must be treated as a whole system, the relationships through the entities should be considered, such as interaction relationship, dependent relationship and the supply and demand balance of finished-product and service (Ran, 2009). The figure 1 depicts a simple supply chain.

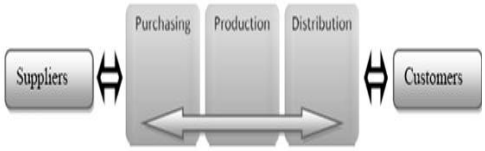

Figure-1: Simple Supply Chain

Supply Chain Integration- Supply chain integration has two basic points: First, flow integration, the main aspect is the convergence of various functions to optimize the efficiency of integration; second, integrated sections, the main sections are the functions of the efficiency of the integration itself, usually happed as a whole system (Yang 2007). Supply Chain Management stakeholders includes suppliers, manufacturers, channel intermediaries and customers integration. Stevenson (1998) proposed four stages of integration: the benchmark organizations, the functions integration, internal integration, and external integration.

Pull Strategies-A pull strategy is related to the just-in-time school of inventory management that minimizes stock on hand, focusing on last-second deliveries. Under these strategies, products enter the supply chain when customer demand justifies it. With a pull strategy, companies avoid the cost of carrying inventory that may not sell. The risk is that they might not have enough inventories to meet demand if they cannot ramp up production quickly enough.

Understanding Supply Chain-

Contingency Approach -The contingency approach applied to supply chain management would assume that there is no universal way to achieve excellence because contextual

factors and situations vary, and they change over time. Supply chain excellence is the capability of a firm to excel in all dimensions of supply chain management that are important to the customer (KUEI et al., 2005). Nuthall (2003) suggests that the pursuit of supply chain excellence has a positive impact on the firm's performance, thus contributing to the achievement of supply chain objectives. The frequency with which firms have changed their supply chain management decisions and practices and refocused their objectives indicates that finding or maintaining the best strategy is difficult in today's rapidly changing business environment. According to Chow, Heaver and Henriksson (1995), the weaknesses of the "one best way" approach to supply chain excellence indicate that alternatives, such as applying contingency theory to supply chain management, could prove to be more useful foci for research. Bowersox, Closs and Stank (1999) also seem to concur that a contingency approach to supply chain management would a better approach to research than a "best practice" approach.

Still, the literature provides little discussion on the contingency approach related to supply chain management. Cigolini, Cozzi and Perona (2004) propose an interesting prescriptive framework to support the definition of the choice of supply chain tools and techniques to be used. In their work, supply chain management is considered to be contingent upon three variables: which phase is dominant within the end products' life cycle (whether most products are in the launch, growth, maturity or decline phase in their product life cycles), the structural complexity of the product itself, and the type of supply chain (i.e., quick, efficient, or lean). Stonebraker and Liao (2006), departing from a similar perspective and exploring product and environmental contingencies, advocate that a strategic fit must exist between supply chain and environmental, strategic, and operations variables.

One important and highly visible contribution to the contingency approach to supply chain management comes from Fisher (1997). This model is also prescriptive. It has been often cited and has appeared in a number of popular textbooks on supply chain management, such as Simchi-Levy, Kaminski and Simchi-Levy (2003) and Wisner, Tan and Leong (2008). Fisher argues that supply chain design and management should be contingent upon the type of product being delivered. According to this notion, products can be categorized as 'functional' or 'innovative.' Functional products are staples that usually satisfy basic needs; do not change much over time; have lower profit margins, longer life cycles, and, more importantly, low forecast uncertainty. Canned soup and washing powder are

examples. Innovative products are the opposite: they have frequent product launches and changes, higher profit margins, shorter life cycles and usually less predictable demand. Here, fashion and electronics products provide good examples.

According to Fisher (1997), each category of product - functional or innovative - should require a different supply chain. Functional products would require more physically efficient supply chains where asset utilization and cost control (e.g., keeping low inventories by using pull systems and seeking economies of scale in all activities) would play a crucial role. Innovative products, however, would require more market-responsive supply chains, where, for example, excess buffer stocks of parts and finished products are normally needed and aggressive initiatives to reduce lead times should be pursued.

Ramdas and Spekman (2000) concluded that in general terms there were no statistically significant differences in supply chain management practices in use between the total sample of innovative and functional producers. However when they compared innovative high performers with functional high performers they found significant differences in practices.This finding reinforces the idea that high performance can be associated with good alignment between context and practices.

Germain et al. (2008) provide an interesting contribution to the contingency approach to supply chain management by studying the links among organizational structure (formalization and integration), supply chain process variability, and performance moderated by environmental uncertainty (a context-related variable). They find out that in a predictable demand environment, formal control (totally mediated by supply chain variability) is a driver of performance, whereas in an unpredictable demand environment (context), integration is a driver of performance (partially mediated by supply chain variability). Their findings also imply that to achieve higher levels of performance, supply chain managers should make choices and decisions that are contingent on context. Managers have always sought the best way to deal with the broad scope of supply chain management decisions and have focused on how different supply chain objectives should be prioritized. Pfohl and Zollner (1997) indicate that the answer to these questions requires an extensive analysis of important logistical contingency factors and their relationships to supply chain management choices. Under a contingency perspective, the right thing to do depends on contextual factors.

System Approach- Systems theory serves to identify the context in which organizations operate, thus enabling managers to understand the environment and how the parts, or subsystems, of the organization are interrelated (Sweeney, 1999).

System Thinking: Systems thinking offers a method for describing and analyzing problems in such contexts, and is therefore well suited to solving the complex and dynamic socioeconomic problems found in logistics systems today. However, the problems reported by many organizations show that the use of systems thinking is insufficiently developed, although it has been with us for several decades. Senge (1992) elaborates on this theme, and claims that firms seem more concerned with detail - as opposed to dynamic - complexity. If firms deal only with detail complexity, they are obstructed from seeing how relations of different kinds reach beyond their own firms and change over time. The nature of the problems reported indicates that many organizations act as autonomous units instead of components of a larger system, and thus neglect the width and scope of their interdependencies with other firms. His discussion is aimed at positioning measurement problems and initiatives in a framework based on systems thinking, suggesting that adopting a systemic view of the supply chain can assist in improving performance. The framework is based on Senge's (1992) ideas about what kinds of explanations to phenomena firms' use, depending on how well they have adopted systems thinking.Firms not recognizing the relationships between phenomena within the context in which they operate characterize the first and lowest level of adoption. Accordingly the problem statement identified, are as follows-

Problem Statement-1: In spite of attempts to integrate, the supply chain exhibits vulnerability during economic slow-down and subsequent market-recovery.

Supply Chain Driver's Approach:

Chopra and Meindl established a framework for analysing supply chains. This includes definitions and examples of supply chains, relationships between supply chain strategy and a firm's competitive strategy, and drivers and obstacles of supply chain performance. The key drivers identified are inventory, transportation, facilities, and information. The explanation of **Four Drivers:**

- **Inventory:** It consists of all raw materials; work in process, and finished goods within a supply chain.

- **Transportation:** It involves moving inventory from one point in the supply chain to another point.
- **Facilities:** A facility is a place where inventory is stored, manufactured or assembled. Hence facilities can be categorised into production facilities and storage facilities.
- **Information:** It consists of data and results of analysis regarding inventory, transportation, facilities, customer orders, customers, and funds.

Problem Statement-2: A holistic approach encompassing contingency systems and drivers approach needs to be developed.

Model for Decision making: Many researchers have suggested models that are deterministic in nature neglecting the uncertainty. Some have suggested stochastic models to deal with uncertainty (Oliveira, Claudia Sagastizábal, and Susana Scheimberg, 2011)

Problem Statement-3: Models for simulating decision-effect during market recovery are insignificant.

Hybrid Approach- Hybrid systems use the advantages of its subsystems to reach a superior result to one system alone. Production-distribution planning is the most important part in supply chain management. To solve this integrated planning problem, either analytic or simulation approach have been developed. However, these two approaches have their own demerits in problem solving (Young Hae Lee, Sook Han Kim & Chiung Moon, 2010).

System Dynamics- System Dynamics, developed by (Forrester, 1961, 1968) identifies cause-effect relationships and structures them in a feedback control framework to understand the dynamic behavior of the systems. The approach professes causality doctrine associated with determinism. System Dynamics is a methodology that has ability to capture and model dynamic complexity of complex systems. Dynamic complexity refers to state where cause andeffect are subtle and where effects over time interventions are not obvious (Senge, 1990). According to (Coyle,1977) a System Dynamics study aims at the following objectives: Explaining the systems behavior in terms of structure and policies, and suggesting changes in structure, policies or both, which will lead to an improvement in behavior .In practical system dynamics work, and as a conceptual framework, it is useful to look at systems in the light of how much certain knowledge about their workings it is possible to acquire, at any rate in principle, and how far it is possible to exert actual and direct control over what goes on. He proposed three sectors in the structure of a firm.

These are the internal environment or the controller (can be controlled and influenced), the complement (cannot be controlled but may be influenced) and the environment (cannot be controlled or influenced). A firm but cannot control its complement.

Causal Framework:

The interaction of the nodes governs the supply chain dynamics. The proposed frame work can be represented as shown in Figure 2.

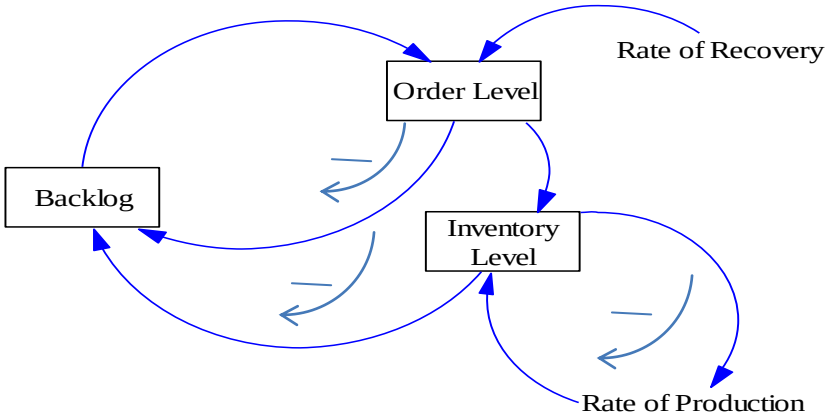

Figure 2: Causal loop diagram

- The state of level variable Backlog indicates the combined performance of Order-Level and Inventory Level. If the Backlog increases then it can be concluded that the plant is unable to meet order received from customer.
- The order-level is also dependent on Accumulated backlog and Rate of Recovery.
- The inventory-level is dependent on order-level and rate of production.
- The Rate of Production, i.e. the auxiliary variable is in-turn dependent on Inventory Level. If the rate of production is high then the accumulated inventory level will also increase, resulting into unnecessary accumulation of inventory.
- On the other hand, if inventory is higher than backlog will be reduced to meet-up customer's order, provided there is enough demand (order-level).
- If the order-level is higher than accumulated inventory level then backlog will be increased, until the rate of production meets the demand.
- If the rate of recovery is high then back-log will be reduced even when there is high-level of orders.

- Moreover, if the order-level is moderate due to moderate rate of recovery and the accumulated inventory is low, and then backlog is also likely to increase.
- Next, if the order-level is low, rate of recovery is high and accumulated inventory is high, and rate of production is also low then backlog is expected to be low.
- Lastly, whatever be the order-level, if the rate of production and inventory level is optimum then rate of recovery is immaterial and backlog is expected to be zero or reduced. This can happen only if there is flexibility in production level i.e., a JIT manufacturing based on Pull strategy.

Therefore, it may be concluded that the rate of recovery is likely to affect the order level which in turn affects the inventory and production rates. If these have imbalances will result in backlog causing order level to fall. Through this causal framework it has been tried to illustrate that a transition is expected from pre-recovery phase (characterized by high inventory level, low production level, zero backlog and low order-level) to the recovery period where the order level is expected to grow either at steady rate or at slow rate or the recovery may take a downward ward dip again.

There are three loops that explain the dynamics of the system, *viz.*

i. **Order Level – Backlog Level Loop:** The increase in Order Level will result in increase in Backlog Level. Increase in Backlog Level will decrease the order level. Hence a negative loop.

ii. **Order Level – Inventory - Backlog Level Loop:** The increase in Order Level will result in decrease in Inventory level. Increase in Inventory Level will decrease the Backlog Level. Increase in Backlog Level will decrease the order level. Hence a negative loop.

iii. **Inventory –Production Rate Loop:** The increase in Inventorywill result in decrease in Production Rate. Increase in Production Ratewill increase Inventory level. Hence a negative loop.

Model Simulations Conditions:

Figure 3 shows the proposed System Dynamics model for simulating the decision-effect during market recovery.

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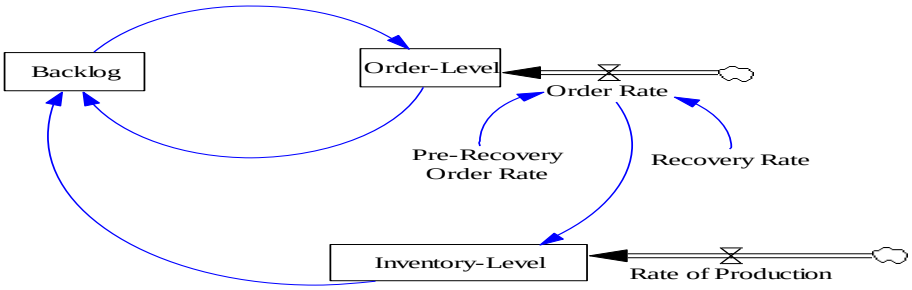

Figure 3: System Dynamic Model for Simulation

Model Simulation- The pre-recovery stage is characterized with the state as:

Order level=Low,

Inventory level=Very High,

Production Level = Low

Capacity Utilization= Low

Figure 4 illustrates the pre-recovery stage graphically.

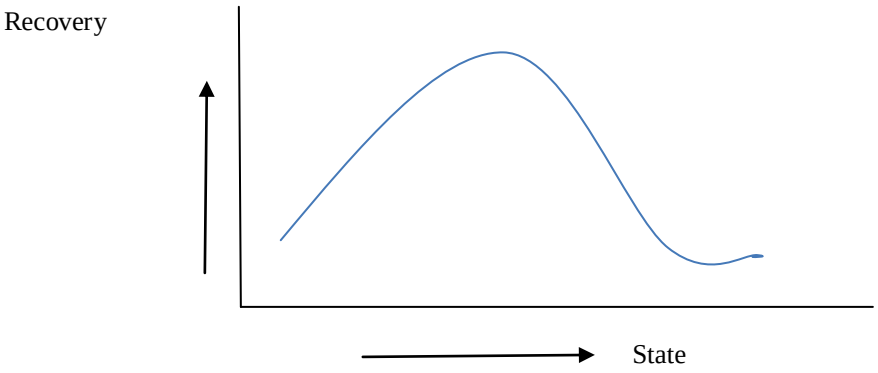

Figure 4: Graph for Pre-Recovery State

Thus pre-recovery with respect to supply-chain can be defined in terms of inventory level, obsolescence, backlog, order-levels and production levels.

In pre-recovery the inventory level expected to be higher, obsolescence higher, production level very low, backlog is zero (0), order-level is low.

These form the initial condition of the system dynamic model.

Figure 5 shows the inventory level during different phases of economic cycle as outcome of simulation of the System Dynamics Model

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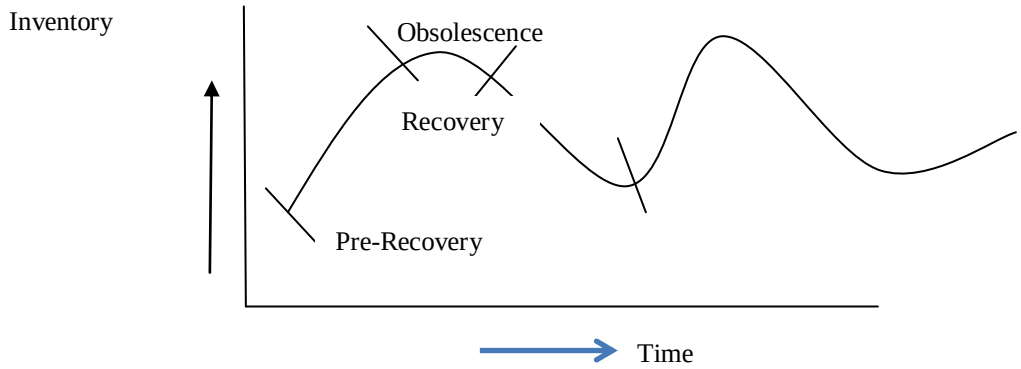

Figure 5: Inventory Level - Recovery vs. Pre-Recovery Phase

In order to meet the increase in order level (during the recovery period), depleting the previously held inventory, firm needs to increase the production capacity to meet the rise in demand. Increasing of production capacity will involve some delay due to time taken to install additional capacity. During this delay period the firm is expected to experience lost sales affecting its credibility. Hence the firm needs to ramp up production with agile manufacturing approach and resort to outsourcing to meet the upsurge in demand. The extent of ramping up production and outsourcing would depend on the rate of recovery.

Simulation of the System Dynamics Model leads to the determination of the right production and outsourcing decisions.

Findings:

This approach suggests **s**ome vital recession-recovery strategies for manufacturers to effectively mitigate supply chain risks, quickly respond to opportunities associated with the economic recovery, as well as operate a more efficient and competitive business i.e. strengthen cash position, realign the supply chain to achieve financial, and similar goals**.**

Conclusion:

This paper concludes that in spite of attempts to integrate, the supply chain exhibits vulnerability during economic slow-down and subsequent market-recovery and a holistic approach encompassing contingency, systems and drivers approach needs to be developed. The system dynamics model enables the policy maker to study the impact of different rates of recovery such as low, moderate, high and fluctuating rates on the supply chain decision

Future Research Scope:

The System Dynamics model presented in this paper may be validated with real life scenarios and data in further research work.

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